stream motion is mainly a local effect of this revolution. Studies of star clusters and of the comparative spectra of near and distant stars have indicated that the amount of absorption or scattering of light in space must be extremely small. The 60-in. reflector has been used to establish magnitude scales over a wide range, the faintest stars included being of photographic magnitude 20·1.

SPECTRA OF CHROMOSPHERE AND CORONA.—The results of measurements of a plate obtained at Vavau, Tonga Islands, during the total eclipse of the sun of April 28, 1911, have recently been given by the Rev. Father A. L. Cortie, S.J. (Monthly Notices, R.A.S., vol. lxxviii., p. 441). The photograph was taken with a prismatic camera under somewhat unfavourable conditions, but it extends far into the red, and twenty-five chromospheric lines not previously recorded have been found between λ 6600 and λ 7640. The majority of these are probably due to iron, but there is a fairly strong line at λ 6941, which remains unidentified. There are indications of a new coronal radiation about λ 7150, which is possibly related to the previously known line at λ 5535·8, in agreement with the theoretical investigations of Prof. Nicholson.

THE METRIC SYSTEM AND DECIMAL COINAGE.

NOTWITHSTANDING the growing demand in this country for our adoption of the metric system of weights and measures and a decimal system of coinage, the Committee on Commercial and Industrial Policy after the War has reported against the early introduction of both these overdue reforms. It is proposed in the following commentary upon the Committee's recently issued report (Cd. 9035, chaps. x. and xi.) to show that the arguments upon which these decisions are based are open to considerable criticism. For ease in reference these comments generally follow the sequence of the report.

The Metric System.

The Result of the Permissive Act of 1897.—In its historical review of the previous efforts to establish the metric system in this country, the Committee states that, although the use of the metric system has been permissive for the last twenty years, the number of metric weights and measures presented annually for verification and stamping is now only about 1 per cent. of the number of Imperial weights and measures similarly presented. The Committee has apparently failed to realise that the Act of 1897 alone could not possibly extend our use of the metric system, because, for example, it is obviously impracticable for tradespeople to have two different sets of weights—in different systems—in concurrent use on their shop-counters. It is also unreasonable to expect British manufacturers to employ the metric system in their workshops so long as our railways are permitted to refuse consignments of their products unless the Imperial equivalents of the weights and dimensions are also stated.

Further evidence of the futility of this Act as a measure for encouraging the use of the metric system in this country is unconsciously supplied by the Committee itself in its statement that even our present limited use "appears to arise mainly in connection with the recent legislation of metric carat weights and the adoption in the British Pharmacopœia of metric weights and measures for the prescription of doses." The 1897 Act has thus proved a dead letter, and further legislation is already long overdue.

As in the case of the daylight-saving scheme, the community as a whole cannot enjoy the benefits of the metric system until its use is established by law.

The Difficulty of Spare Parts and Renewals of Machinery.—The report states that, in order to enable the British machinery-maker to supply spare parts and renewals, it would be necessary for him to continue the Imperial system in use, side by side with the metric system, for possibly a generation after our official abandonment of the Imperial system, and that he would accordingly be required to work in two systems for that period.

This objection evidently arises from an unwarrantable assumption that our adoption of the metric system would necessarily involve altered dimensions of machine parts. Such is not the case, because obviously any dimensions now expressed in inches and parts thereof can be readily expressed in millimetres and parts thereof. It should be remembered that a tolerance of one-hundredth part of a millimetre demands much more accurate work than is usually obtainable in our machine-shops; so that those opponents of metric measures who claim that metric equivalents of Imperial dimensions can be shown only by employing six figures or so after the decimal point are obviously drawing on their imagination and appealing to the credulity of those whose support they seek.

British manufacturing engineers have for years worked in mils (0·001 in.), and the worst the metric system could demand of them. viz. 0·01 mm., would thus represent a saving of one figure in written dimensions. In practice, for small dimensions, two or more figures would generally be saved, because the dimension 0·1 mm. (roughly four mils, or 0·004 in.) would be quite fine enough for most of their work. Equivalents expressed even so approximately as the nearest whole millimetre—thus dispensing entirely with the decimal point—could not differ from the original Imperial dimension by more than one-fiftieth part of an inch.

Furthermore, the passage of an Act requiring all sales to be made in terms of the metric system would not affect the liberty of any person to continue his use of the existing weights and measures for manufacturing purposes until such time as he himself chose to abandon them. All existing patterns could thus be employed for the full term of their useful lives, and when in the normal course they became worn out or obsolete in design they could be economically replaced by new ones based on the metric system.

Manufacturers engaging in new industries should, at the outset, base their designs on the metric system, and it is gratifying to note that this has been done, for example, in the case of the British magneto industry, which has been so successfully established in this country since the outbreak of the war.

The Value of a Universal Language of Quantity.—Regarding the point raised by the Committee that if we now adopted the metric system we should be required to work in two systems for a generation, it may be remarked that, even were this true, it would be much less appalling than our alternative prospect of employing two systems for all time. The fact remains that, whether we like it or not, we already find ourselves obliged to use the metric system to an ever-increasing extent in scientific work, in manufacture, and in export trade; and the retention of our own Imperial system thus handicaps us by compelling us to employ two systems where one would suffice.

When we realise that our national existence depends upon our ability to sell British manufactured goods to all nations, *i.e.* to develop a world-wide trade, it is obvious that Great Britain—more than any other country—would benefit from the establishment of a universal system of weights and measures.

The use of the metric system is already obligatory in thirty-four countries, representing a population of 437 millions, and optional in a further eleven countries having a population of more than 727 millions. By ourselves adopting it we should practically ensure its establishment as the universal language of quantity, but, on the other hand, it is equally clear that the Imperial system could never become the universal system because of its inherent defects.

The Influence upon our Export Trade.—In opposing the proposal that legislation should be introduced whereby all *sales* would be required to be expressed in metric terms, the Committee states that "the continuance of manufacture on the existing system while the sale of the product had to be made on the metric system would be confusing and inconvenient."

This admission illustrates the indifference of the Committee to the "confusion and inconvenience" which it evidently considers British exporters should continue to suffer, because it is precisely under these conditions that we are attempting to expand our overseas trade. After the war it will be just as necessary for Great Britain to organise and develop her export trade—in order to reduce the burden of taxation and restore her financial stability—as it has been for her to organise the manufacture of munitions during the war, and yet the Committee cannot agree to assist our exporters by removing this unnecessary "confusion and inconvenience."

Are we for ever to remain deaf to the advice of our overseas commercial representatives—both Government and private—who for years past have urged us to adopt the metric system? The opinions of these "men on the spot" are apparently quite ignored, as no reference is made to them in the report.

This brings me to the Committee's remarkable statement that, as more than half the volume of our pre-war export trade was with non-metric countries, we should stand to lose more than we could gain if we adopted the metric system. Realising apparently how unsubstantial this argument is, the Committee proceeds to qualify it by saying:—"The position would no doubt be materially altered *if*" the Colonies and other outstanding countries "would simultaneously with us adopt the metric system." It is curious that, in regard to the Colonies, any doubt of their readiness to follow our lead should be entertained, especially as in the same report the Committee states:—"At the Colonial Conference of 1902 a resolution in favour of the introduction of the metric system throughout the British Empire was carried." This desire was confirmed by the Dominions Royal Commission Report of 1917, which stated, in regard to the metric system:—"There is clearly in the Dominions a considerable body of opinion in favour of the change. So far, however, all efforts to induce the community in the Mother Country to agree to a change have proved unavailing."

According to statistics quoted by the Committee in another part of the report (chap. ii.), rather more than one-third of the annual value of the exports of the produce and manufactures of the United Kingdom went to British Possessions during the fourteen years ending 1913, and the item coal represented "fully three-quarters of the total weight of our exports of all kinds."

Obviously, coal could be exported just as readily in metric tons as in Imperial tons, so that if the Committee had boldly stated that Great Britain's adoption of the metric system would certainly be followed promptly by similar action on the part of the Colonies and British Possessions, and probably by America at no very distant date, they could have presented a strong case in favour of the metric system instead of a weak case against it.

In concluding that the United States would be opposed to the metric system, the Committee has apparently failed to appreciate that it was anti-metric only so long as its products were principally destined for home consumption or for export to the British Empire. But note what is happening now that the United States aspires to become an exporting nation in the widest sense. In the last few years the American demand for the metric system has grown enormously, and in his report, dated January, 1916, to the International High Commission relative to the use of the metric system in export trade, Dr. S. W. Stratton (Director of the Bureau of Standards at Washington) said:—"Any manufacturer who, through ignorance, fear of confusion, or lack of enterprise, is unwilling to attempt to meet the requirements of foreign trade should confine his attention to our domestic trade. He should not, however, be permitted to retard the development of foreign trade by his inertia or indifference to the metric system, which is now the legal system in thirty-four of the countries whose trade we seek. Still less should his opposition or his opinion have consideration in comparison with the judgment of those who seek earnestly and by all possible means the extension of trade with metric countries."

Note also the significance of the official announcement published in January, 1918, to the effect that the United States War Department had adopted the metric system for the artillery, machine-guns, and maps required by their armies in the present war. Whether Great Britain or the United States takes the lead in the complete adoption of the metric system, it is reasonably certain that the other would quickly follow, and, in view of our greater dependence on overseas trade, it is clear that we ought to move first.

The Effect upon our Competition with Germany.—The statement that our adoption of the metric system would place us at a disadvantage with Germany should be contrasted with the attitude of the German nation, which, in the early 'seventies, adopted what was known as the French system, notwithstanding the anti-French sentiments then existing on account of the Franco-Prussian War. Since that time twenty-four other countries have likewise adopted what is now truly described as the *international* metric system, and we accordingly remain a non-metric country to our own serious disadvantage. The war has demonstrated the need for greater intimacy of contact between the man of science in his laboratory and the industrialist in his workshop. In Germany the metric system is common to both these partners in progress, but in this country, while the metric system is the language of science, it is a comparatively unknown tongue in our workshops. Is it to our advantage that this estrangement should be perpetuated? If we adopted the metric system at once we should surmount the temporary difficulty of accustoming ourselves to the metric notation long before Germany emerged from under the cloud of the world's disapproval consequent upon her infamous acts in the present war. We cannot, however, rely upon this sentiment lasting more than a few years, so we should act promptly. All our industries will require overhauling when we abandon the manufacture of war munitions in favour of peace products, and it is wrong to assume that we shall simply revert to pre-war standards. New methods, new designs, new ideas will be the order of the day, and the time will be particularly opportune for starting afresh on the metric basis.

The Opposition of the Textile Trade.—Evidence of the antagonism of the textile trade appears in several parts of the report. This attitude suggests the thought that even assuming the textile industry feels so sure of its grip on the world's markets that it can afford to dispense with the benefits of the metric system and to ignore the convenience of its overseas consumers, that is no adequate reason in itself why all the other industries of the nation should be deprived of the support they would derive from Great Britain's adoption of the metric system. It may be recalled that the watch industry of Switzerland similarly held out against the Swiss adoption of the metric system, and that it was accommodated by being specially exempt from the compulsory provisions of the Metric System Act. But what was the sequel? A very few years' experience proved to the Swiss watchmakers that they had denied themselves advantages which their fellow-countrymen enjoyed, and they then accordingly voluntarily fell into line. It is to be hoped the British textile industry will note and profit by this example.

In the meantime, it is well also to bear in mind the facts recorded by the Committee in chap. ii. that "of the yarns exported in 1913, about one-third was taken by Germany" (already a metric country), and that "rather more than half of the total exports of piece-goods went to British Possessions," which, as mentioned above, only await the lead of the Mother Country to justify their adoption of the metric system.

The Educational Aspect.—The Committee's attempt to discount the advantages of the metric system in educational matters is very weak, and may be usefully contrasted with the authoritative statements published in the recently issued "Report of the Committee Appointed by the Prime Minister to Inquire into the Position of Natural Science in the Educational System of Great Britain" (Cd. 9011). One of this Committee's summarised conclusions reads:—"That the present chaos of English weights and measures causes waste of time and confusion of thought, and that there are strong educational reasons for the adoption of the metric system."

The "Improvement" of the Imperial System.—Realising that although it cannot recommend the metric system it also cannot establish the superiority of our existing system, the Committee adopts the expedient of advocating the so-called "improvement" of the Imperial system. To that end the members "emphasise the advantages, already widely recognised, of using decimal subdivisions of our basic units, such as the inch and the pound weight." This leaning to decimalisation is especially noteworthy in view of the contradictory opinion expressed elsewhere in the report that "for practical purposes binary divisions are better than decimal."

In this connection it is instructive to recall the recommendations of the Select Committee of the House of Commons which so long ago as 1862 reported that "it would involve as much difficulty to create a special decimal system of our own as simply to adopt the metric system in common with other nations, and if we did so create a national system we would in all likelihood have to change it again in a few years as the commerce and intercourse between nations increased into an international one." That was fifty-six years ago. Further comment is superfluous. If instead of decimalising English units, we could agree forthwith to express all weights and dimensions in terms of single units (*e.g.* pounds, yards, and gallons), abolishing all the chaotic multiples of 12, 3, 5½, 40, 8, etc., the way would be paved for our early adoption of the metric system.

Decimal Coinage.

The report reviews the various proposals which have been made from time to time, and concludes that our ultimate choice must rest between (*a*) the retention of the £ sterling as the monetary unit and its division into 1000 parts, or (*b*) the creation of a new monetary unit equal to 100 halfpence—viz. a gold dollar of 4*s.* 2*d.*

After recording its opinion as being strongly in favour of the first of these alternatives, the Committee enlarges upon the difficulties incidental to the decimalisation of the £ sterling, and concludes, by a majority (not unanimously), that the change would be inexpedient at the present time or in the immediate future.

The above-mentioned difficulties fall chiefly under two heads, viz.:—(1) The necessary alteration of the value of the penny. (2) The use of three figures after the decimal point.

Of the former it may be said at once that it is high time the penny coinage was changed, because of its failure to meet fluctuations in currency values and gradual changes in the prices of small articles and services.

By way of illustrating the failure of the penny to meet present-day needs, it will have been noted that while the cost of many daily necessaries may have been increased by (say) 20 per cent., it has been necessary to raise the price of halfpenny goods and services by 100 per cent. to one penny, and of penny ones by 50 per cent. to 1½*d.*, because of our lack of coins to represent intermediate values. The case of the penny stamp is a recent example. This unsuitably steep grading of the present coinage has proved a source of hardship, especially to the poorer classes, who are obliged to purchase food and other daily requirements in "pennyworths."

The provision in the new Bill of an enlarged range of low-value coins should greatly facilitate the change from pence to mils. As, for example, neither the 4-mil nor the 5-mil coin would be exactly equal to the present penny, it is thought better to include both coins than arbitrarily to say that the new penny shall be either 4 per cent. less or 20 per cent. more than the present penny. In course of time any coins which experience had shown to be superfluous could be withdrawn from circulation.

The equivalent in mils of any sum now stated in pence would be ascertained by adding one-twenty-fourth part to the number of farthings contained therein, from which it will be seen that each complete sixpence would have its exact equivalent in twenty-five mils. On this basis all new coins could be issued to the public in exact exchange for existing coins, thus avoiding loss to either the individual or the State.

In order to meet the second difficulty, which is more apparent than real, of employing three figures after the decimal point, it is suggested that the present three-column method of cash entry might be retained. The existing cash columns, rechristened £ *f.* *m.* instead of £ *s.* *d.*, would conveniently separate the pounds from the florins and the florins from the mils, and *no decimal point would be required.* Instead of learning "12 pence in a shilling and 20 shillings in a pound," school children would be taught "100 mils in a florin and 10 florins in a pound." Under this arrangement prices lower than a £ would be quoted in florins and mils just as we now employ shillings and pence.

In its criticism of a draft Bill (submitted by the Institute of Bankers) the Committee makes the erroneous statement that this has been adopted also by the Association of Chambers of Commerce and the Decimal Association. What really happened was this: After the bankers' draft Bill had been submitted to the Committee, conferences took place between the three above-mentioned organisations, and a new Bill (based upon the bankers' draft but containing important modifications and improvements) was mutually adopted by the unanimous agreement of all the parties.

Attempts were made to lay these new proposals before Lord Balfour's Committee, but a reply was received to the effect that the Committee had by that time ceased to take evidence, and nothing could be done. This is particularly to be regretted, because the improved Bill meets many of the difficulties mentioned in the Committee's report.

The new Bill has just been before the House of Lords, and consideration of it has been postponed on the understanding that the Government will institute an inquiry into the whole question. The Bill received widespread and influential backing, having been introduced by the Association of Chambers of Commerce of the United Kingdom (representing more than 130 Chambers throughout the country), and supported by the Decimal Association and many organisations representative, among others, of:—*Finance*, the Institute of Bankers; *Commerce*, Chambers of Commerce; *Industry*, Federation of British Industries; *Science*, British Science Guild; *Transport*, Municipal Tramways Association; and many professions and trades. This unanimity of organised opinion augurs well for the eventual adoption of a reform which, as hinted at by the Committee, has possibly suffered more hitherto from the diversity of advice tendered by its advocates than from any real opposition either in or out of Parliament.

Harry Allcock.

PROGRESS OF THE EDUCATION BILL.

DESPITE the pressure of other urgent measures and the consequent limitations as to time, and in spite also of the persistent opposition of certain Members, good progress is being made with the Education Bill in the House of Commons. Already clause 10, the crucial clause of the measure, which is to secure the continued education of young persons from fourteen to eighteen years of age who have entered into employment, has been reached. It is to be hoped that the endeavour of Mr. Fisher to preserve the contact of adolescent youth with the humaner side of life during these formative years, whilst giving effect to all reasonable opportunities for enhancing both knowledge and aptitude in the chosen vocation, may receive complete support and be assured of legal enactment.

It is in this connection satisfactory to find that the great evil of half-time, which has mainly characterised the textile industrial areas of the country, has found little support in the House, and clause 8, section 1, abolishing all exemptions up to the completion of the fourteenth year of age (to come into operation on the close of the war), has been passed without a division. We thus secure that the child in the elementary school will now have at least a complete preliminary course of education and training from the beginning of his sixth to the completion of his fourteenth year, and the nation comes into line with the more advanced industrial and commercial nations of the Continent who are its greatest rivals.

Moreover, liberty to raise the school age until the completion of the fifteenth year of age, with or without exemptions, at the option of the local education authority has secured the assent of the Committee by a very large majority, and it is further provided that adequate provision shall be made in order to secure that children and young persons shall not be debarred from receiving the benefits of any form of education by which they are capable of profiting through inability to pay fees. In view of the necessity of encouraging the development of higher education in county areas, it is satisfactory to find that there was unanimous assent to the abolition of the limit of expenditure from the rate by county council committees.

Provision is made for the due inspection of private schools with a view to the elimination of unsatisfactory establishments by bringing them under the direct supervision of the local authorities and of the Board of Education. A step has also been taken at the option of the local education authority to raise the compulsory age of entrance to the elementary school from five to six years, provided that adequate provision is made in the area for the establishment of duly equipped nursery schools. It is a pleasant thing to note that in the establishment by scheme of joint committees teachers are expressly named as eligible for co-optation. The efforts of the friends of this important measure should now be firmly concentrated upon the provisions of clause 10, so as to secure that the proposals of Mr. Fisher, who has so far piloted the Bill with such admirable tact, shall be given legislative effect. Whatever be the merits of the Hibbert amendment, and they are by no means absent, they are not comparable with the advantages to be gained by the intimate association of young persons with the beneficial influence of the schools up to the conclusion of their eighteenth year.

ORGANISATION OF GLASS INDUSTRIES.

THE Society of Glass Technology held an important meeting at the Institute of Chemistry on May 15, when the president, Mr. Frank Wood, in opening a discussion on "The Glass Industry after the War," advocated the formation of trade councils for the organisation of the various sections. He proposed that a federation should be formed, controlled by a council consisting of sectional representatives, both manufacturers and men, together with representatives of science, the Government, and finance. The matter should be taken in hand immediately, and every effort made to secure workmen and machinery to enable the country to supply all its requirements, instead of about 20 per cent. in pre-war days. To do this, Government assistance is necessary. Without protection in some sections and prohibition in others, there would be a deluge of foreign glass just when their furnaces and shops ought to be undergoing repair and when time would be required for the training of workers. They should be ready for the future, and the Optical Munitions and Glassware Supply Department of the Ministry of Munitions, to which they were so much indebted, should continue in being to help them. Mr. Connolly voiced the need for a dump-proof Empire in order that a fair chance might be given to home production. Sir Frank Heath dealt with the necessity for bringing science to bear on the matter, assuring the meeting of the desire of the Government to assist research through industrial organisations. The conditions under which grants are made are not onerous, and the researches are conducted free from meticulous interference from headquarters. Mr. Douglas Baird referred to the production of chemical ware, which will not be able to stand on its feet for some time without the aid of "foster-parents." Sir Herbert Jackson spoke hopefully of the general outlook. National prestige must supply the stimulus for pulling together after the war. Their representatives should be brought into collaboration with Government representatives to deal with the problems before them. Mr. Biram, of the Ministry of Munitions, acknowledged the great help of the manufacturers in the production of war material; the future would call for all their energy and enterprise. Dr. Rosenhain appealed for the fullest utilisation of scientific results and the interchange of knowledge and experience. Mr. S. N. Jenkinson said that the industry must make itself efficient if it is to be supported by the Government. Many other members joined in the discussion, and it